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A Simple Hydrothermal Synthesis, and Characterization of SnO_2 micro sheets and micro flex like Structures

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ABSTRACT

Nanostructures of metal oxide have attracted a lot of attention because of their superior properties over their bulk counter parts. Tin oxide (SnO_2) in nanometric form is one of the most important semiconductor oxides because of its properties and potential applications. This is widely used for solar cells, gas sensors, and transparent electrodes. However, it should be noted that the size and morphology of the materials greatly affect their properties as well their further applications. Recently, solvothermal routes have been developed to fabricate SnO_2 nanostructures. The hydrothermal method is one of the most promising routes due to its low cost, environment friendly, mild conditions, and potential advantage for large scale production. Besides, hydrothermal treatments present a positive effect in enhancing thermal stability and gas response. Zinc oxide doped Tin oxide (Zn-doped SnO_2) microsheet and Tin oxide (SnO_2) microflex like two-dimensional crystalline structures have been synthesized via a simple solvothermal method. The microstructures showed orientation growth behavior and sheet & flex like morphology highly useful for gas sensing application.

Key words: SnO_2.microsheet, microflex, microstructures, morphology, hydrothermal.

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INTRODUCTION

One–dimentional (1D) nanostructured metal oxides have attracted a lot of attention because of their superior properties over their bulk counter parts. SnO_2 in nanometric form is one of the most important semiconductor oxides because of its properties and potential applications. This is widely used for solar cells, gas sensors, and transparent electrodes. However, it should be noted that the size and morphology of the materials greatly affect their properties as well their further applications. Recently interest has been developed in tin oxide due its mechanical and chemical stability, environmental and good thermal properties. In the bulk form, SnO_2 has a tetragonal structure (a = b = 4.737A and c= 3.186 A) similar to the rutile with wide energy gap (Eg = 3.67 eV, at 300K), an insulator and becomes n-type semiconductor. SnO_2 plays an important role as transparent conducting oxide material with remarkable opto electrical properties. Up till nowSnO_2 with various nano and microstructures have been successfully prepared using various methods including thermal evaporation. Recently, solvothermal routes have been developed to fabricate SnO_2 nanostructures. The hydrothermal method is one of the most promising route s due to its low cost, environment friendly, mild conditions, and potential advantage for large scale production. Besides, hydrothermal treatments present a positive effect in enhancing thermal stability and gas response.

Here, we reported large scale growth of single crystalline SnO_2 nanoflowers using $SnCl_4$:$5H_2O$ as a precursor by a hydrothermal route. In the synthesis process, alcohol and water, which were friendly to the environments, were used as solvents.

METHODOLOGY

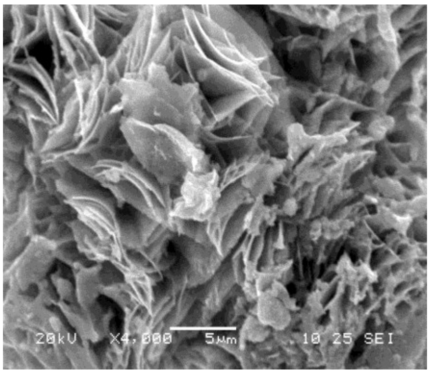
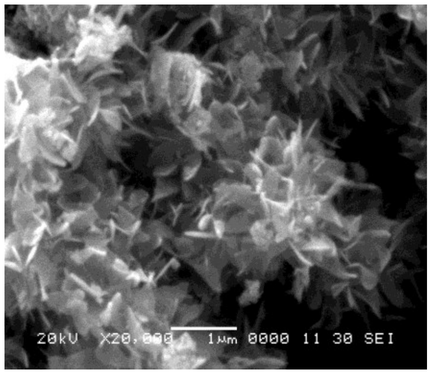
In a typical synthesis, the experimental procedure is described as follows: 0.45 gm $SnCl_4$:$5H_2O$ and 0.4 gm NaOH were dissolved completely into 40 ml basic mixture of ethanol and water (1/1V/V). Then 0.08 gm citric acid was dissolved into the mixture solution. A white precipitate formed was stirred using magnetic stirrer for few hours. Afterwards the as–obtained solution was transferred into a Teflon –lined stainless steel autoclave, sealed and maintained at 180^0C in an electric oven for 18 Hrs. After cooling to room temperature naturally, the product was collected by centrifugation, washed with distilled water and ethanol for several times, finally dried in an oven at 60^0C for 6 Hrs. To investigate the mechanism of crystal growth and morphology evolution of SnO_2 in the system, different hydrothermal reaction times and stirring times of precursor solution were tested.

Characterization:
The crystallinity and phase purity of the as synthesized products were characterized by X-ray diffraction (XRD) analysis using a Bruker Advance (JEOL JEM) diffractrometer (Cu Kα, λ =1.5418A) in the range of $10^0 \leq 2\theta \leq 80^0$. The XRD pattern figure- d showed the presence of the tetragonal structure. The morphologies of the as synthesized SnO_2 product were characterized using scanning electron microscopy (SEM) (JEOL). The SEM images **figure a, b, c** show sheet, flex and flower like morphology of the as-synthesized tin dioxide micro structures. The chemical composition was analyzed by energy dispersive X-ray analysis (EDAX), which is in the earlier reported composition ratio.

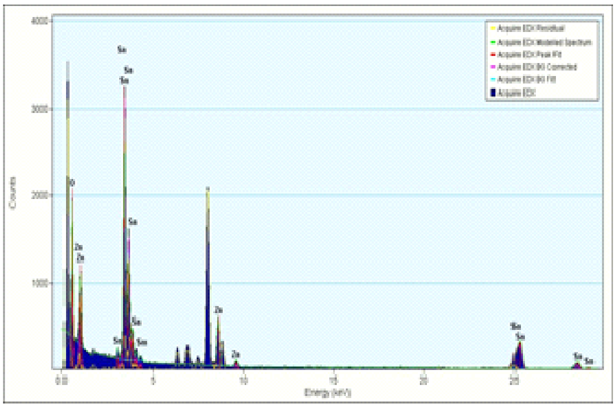
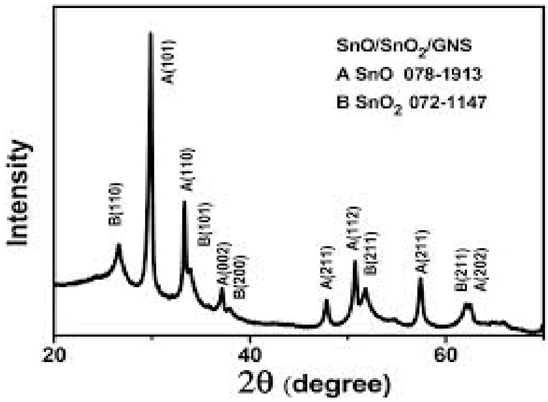
RESULTS AND DISCUSSION

The XRD spectrum of the prepared powder is shown in figure d in agreement with the standard for rutile bulk SnO_2.No other peaks were observed indicating pure crystallinity of the obtained SnO_2 powder. The sharp peaks suggest high crystallinity of the as synthesized SnO_2 sample. Figure a,b,c shows a typical SEM image of the as synthesized product.

The morphology of as synthesized SnO_2 product was characterized using scanning electron microscopy (SEM). The SEM image show sheet and flex like morphology of the as-synthesized tin dioxide microstructures. The structure of SnO_2 microstructures were characterized by X-ray diffraction (XRD), The XRD pattern showed the presence of the tetragonal structure. The chemical composition was analyzed by energy dispersive X-ray analysis (EDAX), which is in the earlier reported composition ratio. We report on the large-scale hydrothermal synthesis of SnO_2 microstructures.

(a) **(b)** **(c)**

(d) (e)

Fig.-1. SEM images of as grown product. **[a]** Micro sheets **[b]** Micro flex **[c]** Nano flower[d] EDS spectrum [e] XRD pattern

CONCLUSION

In summary, large scale SnO_2 nanostructures were successfully synthesized via a simple hydrothermal method. The as- synthesized products consists of micro sheet and flex like structures and nano flower like structures of uniform size. The as synthesized products have potential application in gas sensor, field emission display devices.

Conflicts of interest: The authors stated that no conflicts of interest.

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